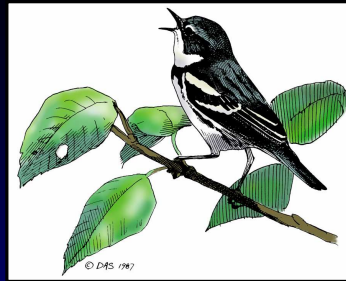


***Cerulean Warbler:
Population status and
breeding habitats***



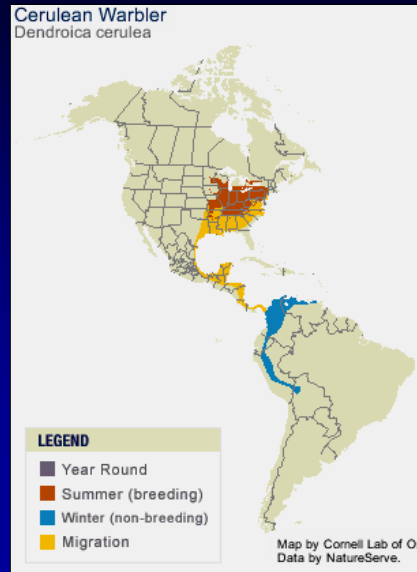
***Dendroica cerulea: estado de las
poblaciones y hábitat de anidación***

Sara Barker Swarthout – Cornell Lab of Ornithology
Kenneth V. Rosenberg – Cornell Lab of Ornithology
David Beuhler – University of Tennessee
Paul Hamel – US Forest Service
Kamal Islam – Ball State University
Jason Jones – Vassar College
Amanda Rodewald – Ohio State University
Petra Wood – West Virginia University

This talk represents the synthesis of our knowledge to date contributed by many of the CERW experts, most of whom are in the audience today. I am going to summarize what we know about the status of Cerulean populations including the most current info about distribution, population trend and size, and then summarize our general knowledge of breeding habitats at different geographic scales. In the talks that will follow we'll hear more details about specific habitat relationships and also the little that we know about demographics.

Cerulean Warbler: distribution

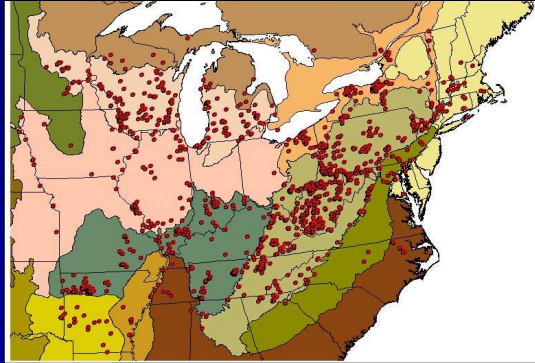
- Breeds in eastern North America
- Winters on east slopes of the Andes in northern South America
- Migrates through Central America and Gulf Coast



As you probably know, the breeding range of the Cerulean is throughout most of eastern US and southeastern Canada and wintering primarily on the east slopes of Andes of Northern South America. We know very little at present about migration pathways and concentration areas. This will be the subject of a later talk in this symposium and we will also hear several presentations on wintering ground information.

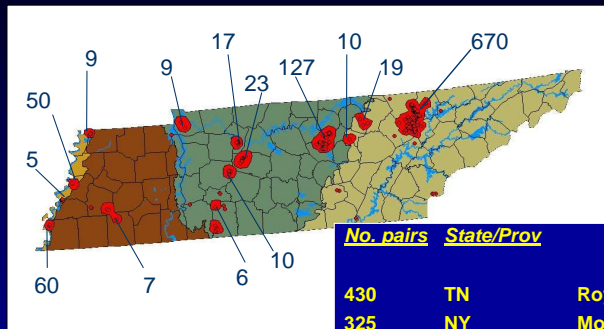
Detailed Breeding Distribution

- Cerulean Warbler Atlas Project (1996-2003)
- Over 3,000 sites surveyed
- Largely restricted to Central Hardwoods biome



I'm going to concentrate on what we know about breeding distributions. To clarify the current distribution of Ceruleans we implemented the Cerulean Warbler Atlas Project from 1996-2003 which asked knowledgeable birders throughout the range to identify known populations. This map shows the roughly 3,000 sites identified with Ceruleans. The outline of the range conforms very nicely with the central hardwoods biome of the eastern US.

Population Concentrations



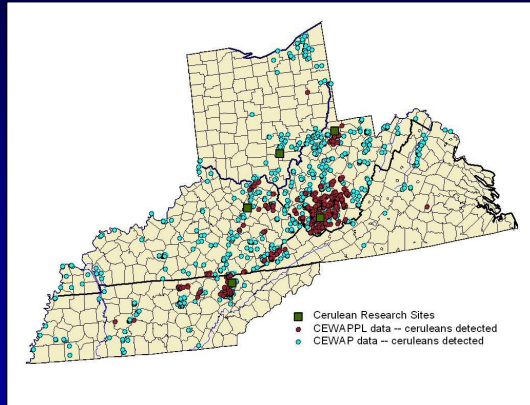
<u>No. pairs</u>	<u>State/Prov</u>	<u>Site</u>
430	TN	Royal Blue Wildlife Management Area
325	NY	Montezuma Wetlands Complex
300	IL	Kaskaskia River
240	TN	Center Hill Lake, Edgar Evins State Park
200	IN	Big Oaks NWR
200	IL	Shawnee National Forest
200	ON	Queens Univ. Biological Station
175	MI	Kalamazoo River, Allegan St. Game Area
165	NY	Alleghany St. Pk. And vicinity
145	TN	Frozen Head State Park

As part of the atlas we identified specific pop concentrations in each state as potential targets for conservation. This table shows the top 10 specific sites which include the Cumberland Mountains of eastern TN and the Montezuma Wetlands complex in upstate NY. We have these maps and tables for every state and province within the breeding range. In many states these likely represent the majority of the Ceruleans that exist, but in the core of the species range distributions may be more continuous.

Surveys on Private Lands (2003-2006)

Proactive partnership with industry – NFWF grant to NCASI

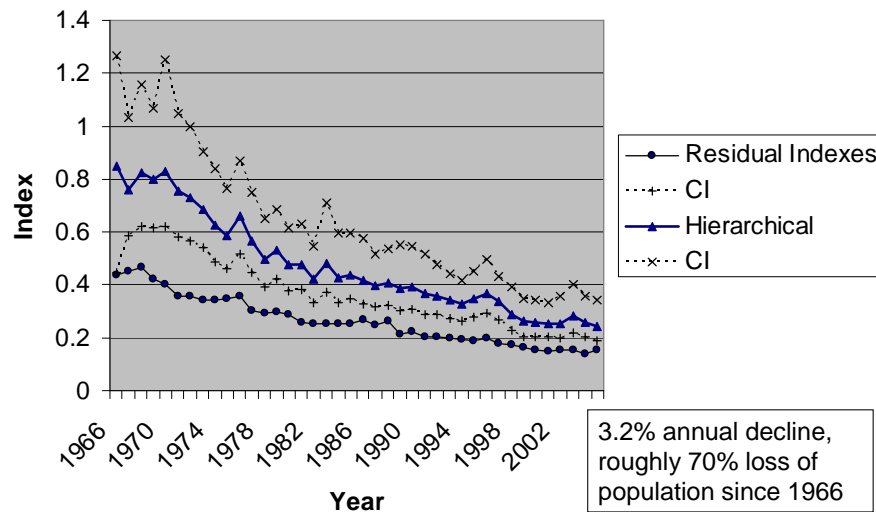
- Landowners conducted surveys at 2,200 sites.
- Ceruleans were located at roughly 30% of all sites surveyed.
- Important gaps were filled for distribution atlas in core of range.



To fill in gaps within the core of the range, which includes vast areas of private lands, we have been partnering with forest industry groups and the NFWF to engage private landowners in surveying for Ceruleans in these areas. This work is ongoing and is designed to inform habitat modeling and forest management research that Dave Beuhler will be addressing in the next talk.

Population Trend (BBS)

Cerulean Warbler (Survey-Wide)



(Check the 70%) (What's name of analysis?)

Now let's talk about pop trends. Pretty much our only information on long term pop trends comes from BBS which now gives us roughly 40 years of data. This graph represents the latest and most sophisticated analysis from the BBS that John Sauer presented in July at a meeting with the USFWS to discuss the possible listing of Ceruleans as threatened under the endangered species act. Basically this puts confidence limits, referred to as credible interval in this analysis, around the trend line which indicates an annual rate of decline of 3.2 percent between 1966 and 2005. The magnitude of this declining trend is consistent with almost all the previous BBS analyses and is consistent across major portions of the species range.

Population Trend Exercise

What was the true historical population trend for Cerulean Warblers rangewide 1966-2005?

Panelists had 100 points to distribute among predetermined categories to reflect their certainty or uncertainty.

LESS DECLINE than BBS credible interval
($<2.0\%/yr$ or a positive trend)

WITHIN BBS credible interval
(between -2.0% & $-4.2\%/yr$)

MORE DECLINE than BBS credible interval
($>4.2\%/yr$ decline)

(Can we get rid of everything but the first sentence of the white text??)

But some people have criticized the BBS trend estimate pointing out that the BBS is a roadside survey and might not accurately reflect the trends of interior forest birds such as the Cerulean. At the recent listing meeting a panel of experts, including biologists and statisticians, were asked to rate their confidence in the most recent BBS trend analysis for Cerulean. Specifically they were asked whether the population trend was most likely within the credible interval of 2% to 4% per year or whether the trend was less or more of a decline than the BBS indicated.

Population Trend Exercise Results

**What was the true historical 1966-2005
range-wide population trend for
Cerulean Warblers?**

Less decline than BBS c.i. (<2.0%/yr decline or positive)	20	10	10	20	20	3	5	5	10	15
Within BBS c.i. (between -2.0 and -4.2%/yr)	70	80	80	60	75	95	80	75	80	75
More decline than BBS c.i. (>4.2%/yr decline)	10	10	10	20	5	2	15	20	10	10

(Can we get rid of entire white paragraph?)

This table shows how panelists voted. Each column represents one panelists distribution of 100 points. They expressed strong confidence that the average 40-year Cerulean population trend was within the credible interval of the hierarchical BBS trend analysis. Most importantly very few people working on Cerulean believe that there is much of a chance that the species is not in decline.

Panel Discussion on Trend

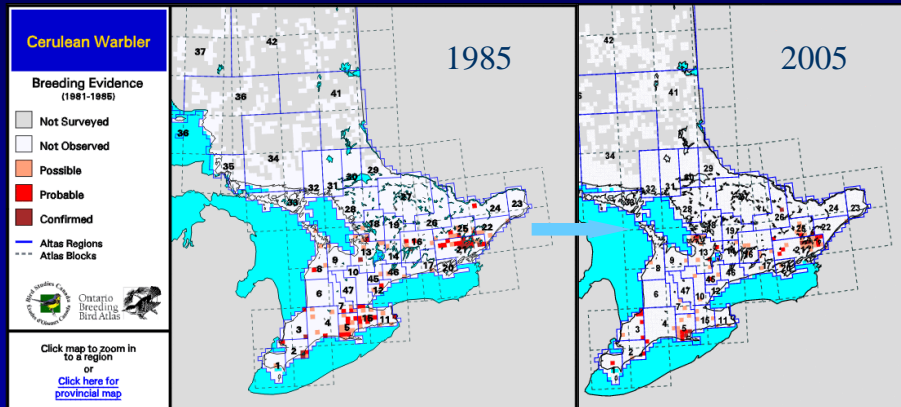
- BBS only samples a small portion of the population – does this influence certainty in BBS trend?
 - Experts did not think there was any serious bias in the way BBS samples Cerulean Warblers, even though numbers counted are low; sampling design is adequate to avoid bias
 - Range-wide, core, and edge trends all similar – consistency increased experts' confidence

(Where do core and edge of range come from?)

In the ensuing discussion most panelists did not believe there was a serious bias in the way BBS sampled this species. The fact that range-wide trends and trends at the core and edge of range were all so similar, increased their confidence in the BBS trend. Hopefully this will put to rest any doubts that the Cerulean is a declining species.

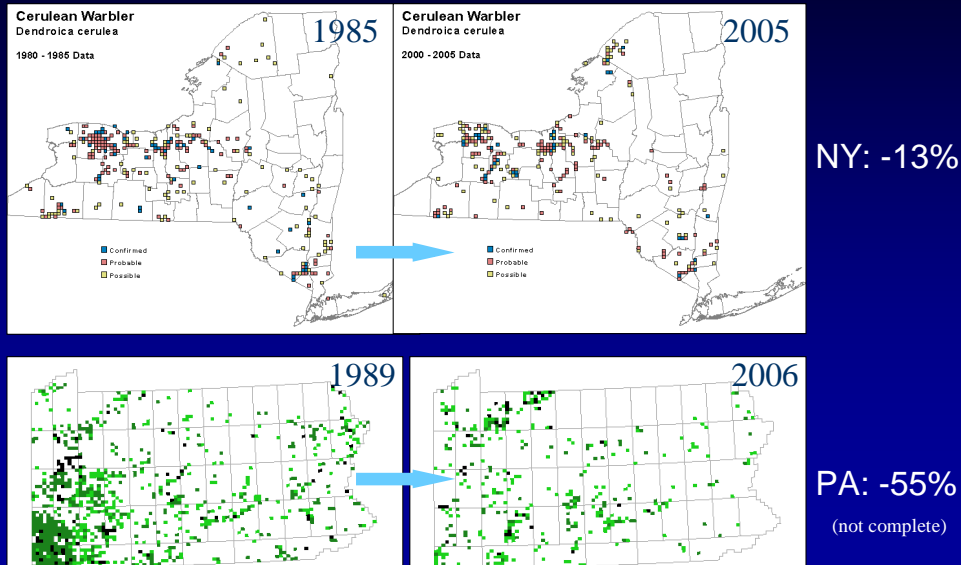
Change in Distribution: Ontario

13% decline in number of blocks with breeding evidence



Even though the Cerulean has declined overall, a range expansion towards the NE had been well documented through the latter part of 20th century. There is still talk of the CERW continuing to expand in the NE. However we now have data from breeding bird atlases that have been repeated at 20 year intervals from 3 places in the NE that are telling a different story. In ON where Jason J and his group has carried on their work, the atlas data clearly shows a shrinking of the birds range since 1985 with 13% decline in the number of atlas blocks with breeding evidence and there has been no further expansion to the north. CERW have run up against unsuitable habitat on the Canadian shield.

Change in Distribution: NY +PA



Amazingly NY has exactly the same percentage decline in number of blocks as ON. Especially disturbing is the shrinking distribution in the stronghold within the state, the Great Lakes Plane and the Hudson Valley. In PA the atlas is not yet complete, but clearly shows a major shrinking of the range around growing urban areas in the SW and eastern part of the state.

So we now believe that the expansion into the NE that took place during the second half of the 20th century stopped and declines are now evident in that same region.

CEWA Population Estimates

Extrapolate from BBS relative abundance

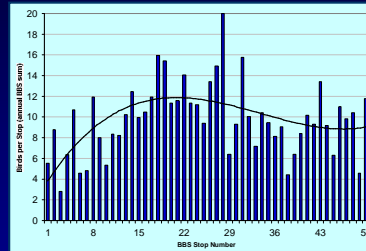
Each stop = 400m
radius "point count"



50 stops = 25.1 km²

Cerulean Warbler detection class = 120m;
BBS route = 2.5 km²

Pair correction = 2.0



Time of day correction = 1.38

**Total "BBS" population estimate for
Cerulean Warbler = 560,000 individuals**

So switching now to pop size...As part of the development of the North American Landbird Conservation Plan, PIF derived the first estimates of total pop size for all north American land bird species. Relative abundance data from the BBS was used to extrapolate to population size. By treating a BBS route as a series of point counts with a 400 meter radius the total potential area surveyed by each route is 25 square Kilometers. We applied a series of correction factors that accounted for the detection distance of each species – so for Cerulean the detection distance is 120 m reducing the area surveyed by the BBS route to 2.5 square kilometers. We also applied a time of day correction accounting for the peak period of singing in the morning and assumed that each bird counted on the BBS represented 1 member of a breeding pair. Using this method to estimate a population for each BCR and then summing across the range of the species, we derived a population estimate for Cerulean of roughly 560,000 individuals or 280,000 pairs.

Reconstructing Time Series

- Ratio of index in 1995 to index at time t

1995	0.348	560000.0	1.000
1996	0.367	590341.3	1.054
1997	0.336	540079.0	0.964
1998	0.290	466786.7	0.834
1999	0.261	419557.9	0.749
2000	0.257	412438.0	0.736
2001	0.253	406499.6	0.726
2002	0.255	409745.3	0.732
2003	0.281	451212.6	0.806
2004	0.260	417685.1	0.746
2005	0.243	390954.4	0.698

If we accept that this pop estimate represents the mid 1990s then we can project a time series based on the BBS trends to estimate the current pop right now. If we assume that the pop has continued to decline at the rate of 3.2% per year since the 1990s then there are roughly 390,000 Ceruleans today. So we've lost another 30% of the population just since 1995.

Population Size Scoring Exercise

What was the true Cerulean Warbler population size range-wide in the 1990s?

Population Size Rangewide	Score
Much less than the PIF estimate (< 300,000)	
Lower half of ~ PIF estimate range (300,000 - 600,000)	
Upper half of ~ PIF estimate range (600,000 - 900,000)	
Much greater than the PIF estimate (>900,000)	

But do we have any confidence at all in the PIF estimate to begin with? At the FWS listing meeting the panelists were again asked to rate their confidence in the population estimate by saying whether they believe the real pop size is smaller, larger or within the range of the PIF estimate.

Population Size - Results

The experts expressed a belief that the true population size in the 1990s was most likely within the upper and lower bounds of the available estimate.

Population Size Rangewide										
Much less than the PIF estimate (< 300,000)	0	0	5	0	5	5	0	5	0	0
Lower half of ~ PIF estimate range (300,000 – 600,000)	5	20	40	30	10	30	20	70	10	30
Upper half of ~ PIF estimate range (600,000 – 900,000)	70	80	40	40	70	40	60	25	70	55
Much greater than the PIF estimate (>900,000)	25	0	15	30	15	25	20	0	20	15

Through this exercise the panelists expressed a belief that the true pop size in the 1990s was within the upper and lower bounds of the available estimate. However most people thought that the estimate of 560,000 might be a bit low but it was unlikely that there were more than twice that number. (May be underestimating but not by much). We were somewhat surprised by the level of confidence in this crude estimate and we believe that it does represent an order of magnitude approximation of the population of Ceruleans that we are trying to conserve.

Population Status

- 70% population loss since 1966
- Declines in core of range
- Historic expansion to Northeast – but recent declines
- Population estimates and conservation objectives



(something about what trend and population means) (WORK on this slide!)

So to summarize what we've got so far regarding population status...

- 1.
2. Especially troubling are declines in core of range
3. Recent declines – BBA data is telling us
4. Population estimates are reasonable and can help us set conservation objectives

birds declining, historic

(Knowing something about pop size tells us how threatened the pop might be and gives us an idea of how many birds we're dealing with and ultimately how much habitat needs to be provided)

General Habitat Relationships

- Large tracts of mature deciduous forest
- Ridge tops, floodplain and mesic cove forests.
- Common denominator = emergent, structurally diverse canopy



Switching gears, I'll now talk about habitats. There is broad consensus that the CERW requires large tracts of mature deciduous forest. Throughout its range, however, this species occupies seemingly very different habitat types including dry ridge tops, riparian floodplains, and mesic cove forests throughout the Appalachian Mountains. The common denominator for all of these habitat types seems to be the presence of an emergent, structurally diverse canopy layer.

Habitat Relationships: Landscapes

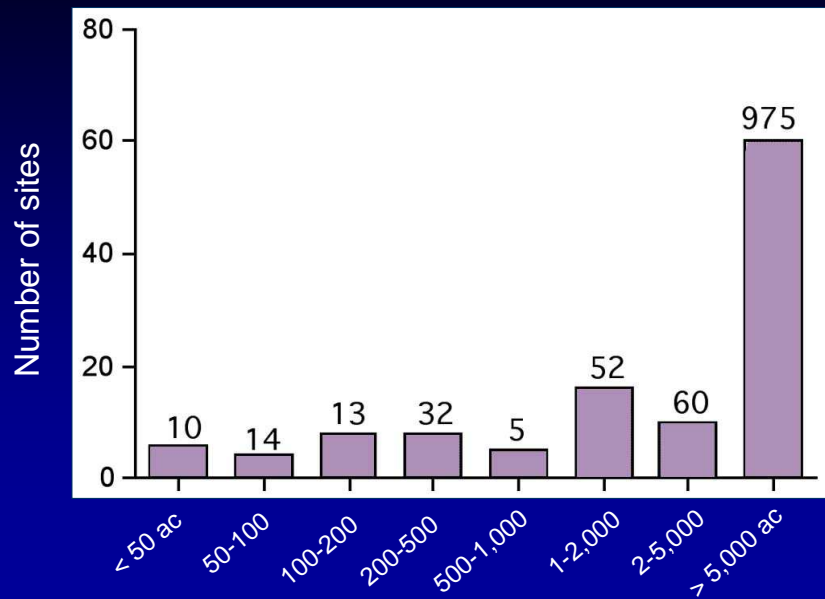
- Area sensitivity
 - 1,780 ac (Robbins et al 1992)
 - 4,000 ac in MAV (Hamel)
- Edge avoidance
- Regional variation in sensitivity



(Robbins data from where?)

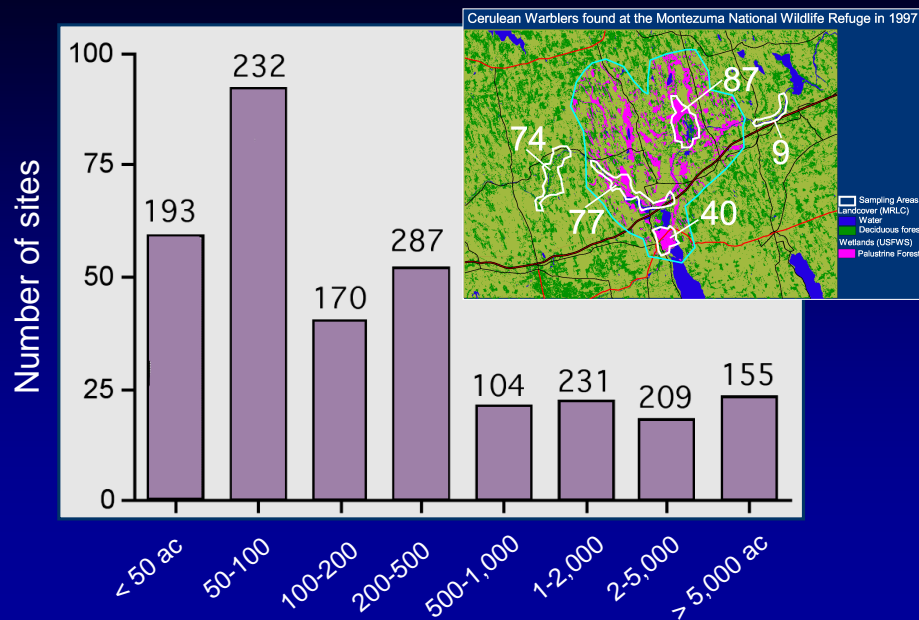
Ceruleans are typically considered an area sensitive species. Published data from Robbins and from Hamel in the Mississippi Alluvial Valley, indicate large minimum tract size. We also have evidence that the Cerulean is a forest interior bird and avoids hard edges of forest such as large open mine lands. However we also are accumulating data indicating regional variation in area sensitivity.

Forest tract size -- Southeast



For example from the Cerulean Atlas the vast majority of sites with Cerulean in the SE were in very large tracts of forest that corresponds with the large tract sizes described by Robbins and by Hamel.

Forest tract-size – Northeast

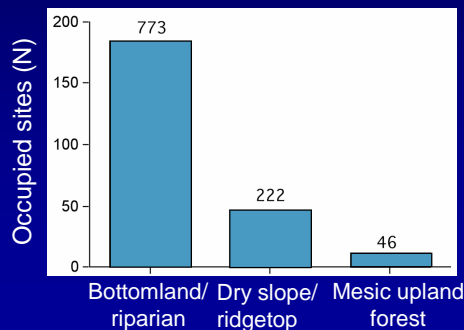


However in the NE region many CEWA were found in much smaller tracts of forest. For example around the Montezuma NWR in upstate NY, Ceruleans occupy small, fragments of bottomland surrounded by agriculture as shown by the pink areas in the inset map. We are currently in the process of investigating area and habitat requirements in this region to test whether the pattern that we found during the atlas project is really true.

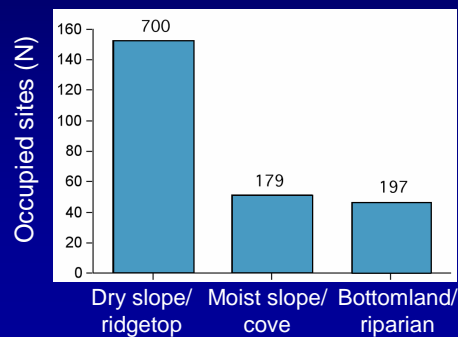
Geographic Variation in Habitat Use

Within a region, Cerulean Warblers are often specialized or show bimodal distribution.

New York Habitats (N=240)



West Virginia Habitats (N=240)



Within a region they are usually quite specialized and often show a bimodal distribution -- occurring in bottomlands and adjacent ridge tops, but not in-between. For example in NY the majority of birds were found in bottomland habitats but with a fair number on dry ridge tops and very few birds found in the vast areas of other forest throughout the state. In WV the majority were found on ridge tops which was not the traditional habitat that Cerulean have been associated with previously in the literature.

(There's a lot of variation from region to region within specific habitats. In any given region they are usually quite specialized and often show a bimodal distribution occurring in bottomlands and adjacent ridge tops, but not in-between. For example in NY the majority of birds were found in bottomland habitats but with a fair number on dry ridge tops and very few birds found in the vast areas of other forest throughout the state. In WV the majority were found on ridge tops which was not the traditional habitat that CERW have been associated with in the literature.)

Habitat Relationships: Forest stand structure

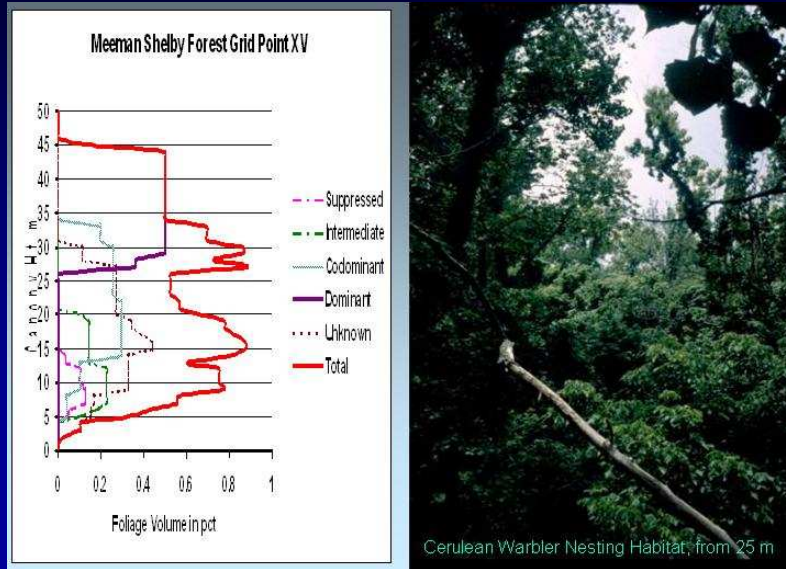
- Density by stand age distribution
 - Prefer later succession; mature sawtimber+
- Tree size and height
 - Larger than average diameter; stand and nest tree
 - Relatively tall trees for diameter class
- Importance of canopy gaps?
 - Canopy heterogeneity vs. canopy gaps

At the scale of the forest stand, we know that Cerulean Warblers occur in higher densities in older forest stands - they prefer forests with mature sawtimber-sized trees or larger.

Forests with Ceruleans have been shown to contain trees that above-average diameter for their size class, AND trees that are relatively tall for their diameter -- in other words trees that have been released from competition and have grown taller than trees around them.

Because of the importance of these emergent canopy trees, there has been much focus on how this canopy heterogeneity is achieved through small-scale disturbance in the forest. In particular, there is still disagreement as to whether small canopy gaps, which can be created by treefalls or through active management, preferentially used by Ceruleans -- obviously this could have important ramifications for management to promote Cerulean Warbler habitat....

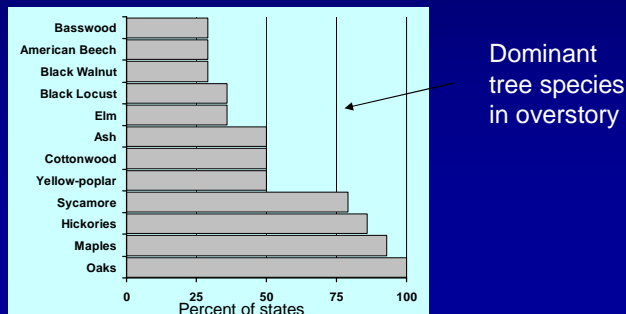
Habitat Relationships: Forest stand structure



Heterogeneous vertical distribution of vegetation in stands may be the common thread in understanding Cerulean breeding habitat, whether due to stand structure, as illustrated in this foliage profile from study site in the Mississippi Valley (Hamel), or due to topography, or both. However, Existing methods to measure this structure are either too crude or often cannot be applied at relevant heights. Cerulean researchers are working on new methods, such as optical methods that are promising but imprecise. In the end, describing how to produce this structure through management may be easier than measuring it.

Habitat Relationships: Tree species

- Preferred tree species vary by region
- Overall importance of oak-hickory
- Shade tolerant vs. intolerant species
- Nest trees vs. singing/foraging trees
 - Large, tall sawtimber trees for male song perches
 - Long-limbed midstory trees for female nest sites



In terms of tree species a large variety of trees have been identified as being used by CERW for nesting or singing. This graph from the CERW atlas project shows the dominant tree species at important sites in each state. Some trees, oaks hickories, maples and sycamore were identified at sites in a large majority of states whereas other trees such as cotton wood, yellow poplar, and others were important only in parts of the species range. Throughout their distribution CERW seem to be pretty closely tied to oak hickory forests or to bottomland dominated by either sycamore, cottonwood, or red and silver maples. These tree species represent both shade tolerate and shade intolerant species which can grow to achieve the desired structure of producing a tall emergent canopy under different conditions at various sites.

Data from the ON study sites indicate that structurally different trees may be important for different life history functions, for example males will use the tallest emergent trees as song perches whereas females may seek long limbed mid-story trees for nesting.

(In terms of tree species there is a wide range that they use again throughout their distribution. It seems as if there are no species preferences, not true, in any given area they may be very particular in the species that they are using. (Appear to be generalized in tree use, but state by state they seem to be very particular about tree use in a given location))

Graph is a summary of data from CERW atlas in which tree species were identified show percentage of states where different tree species were dominant at CERW sites. Oaks, maples and hickories were most universally identified trees whereas



Conclusions



- Cerulean Warbler – small population in range-wide decline.
Dendroica cerulea – población pequeña en amplio rango de declive
- Regional variation in habitat requirements.
Variación regional en sus requerimientos de hábitat.
- Still need to evaluate limiting factors and causes of population decline.
Se necesita estudiar aun los factores limitantes y causas de la reducción de la población.
- Need to link demographic variation with landscape and habitat variation.
Se necesita ligar la variación demográfica con el paisaje y la variación en el hábitat.
- Management should mimic natural disturbance and promote mature stand conditions with broken, emergent canopy.
El Manejo debe imitar las perturbaciones naturales y promover condiciones de bosques maduros con dosel emergente y claros.

-In conclusion, we know a lot about the status and habitat requirements of the CERW, the total pop is very small compared with other passerine migrants which mostly number in the millions and this pop is continuing to decline at a steady rate throughout the species range.

-Even though the species uses a wide range of habitat types and tree species, there is significant regional variation in habitat use and within a given area CERW are often quite specialized.

-WE still don't know very much however about why CERW are declining what are the most important limiting factors and whether they occur on the breeding grounds during migration, or in winter.

-Future research should focus on linking demographic parameters with landscape and habitat variables in order to better understand the causes of population change.

-And finally, as you will hear in the next few talks, we are in the process of learning how to manage forest habitats to enhance CERW pops, especially by mimicking natural disturbances that promote the specific structural features that CERW prefer.